Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center

ATMOSPHERIC DYNAMICS Pty Ltd

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Addendum

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1. Introduction

Katestone Environmental has been commissioned by Atmospheric Dynamics Pty Ltd to prepare a plume vertical velocity assessment of a proposed gas-fired power station at Russell City Energy Center in California. The results of the assessment can be found in the Katestone report "Plume Vertical Velocity Assessment of a Proposed Gas-Fired Power Station at Russell City Energy Center" Final report June 2007.

This report presents results of two operating scenarios for the gas turbine to be operated at the Russel City Energy Center in California and should be read in conjunction with Katestone Environmental, 2007.

2. Emission characteristics

A summary of the stack configuration and plume emission characteristics of the proposed Russell City Energy Center (RCEC) gas turbine scenarios are presented in Table 1 below.

Table 1: Stack characteristics for the proposed RCEC gas turbine scenarios

Parameter	Units	Scenario 1 Gas Turbines	Scenario 2 Gas Turbines
Number of stacks	-	2	2
Location	AMG (mN, mE)	576552.23 4165363.93 576515.65 4165363.93	576552.23 4165363.93 576515.65 4165363.93
Stack height	m	44.2	44.2
Stack diameter	m	5.49	5.49
Volume Flow per stack	m^3/s	525	534
Single plume buoyancy flux	m^4/s^3	346	392
Exit velocity	m/s	22.2	22.55
Temperature	°C	82	89.44
Stack separation	m	36.6	36.6

The buoyancy of Scenario 2 is approximately 13% higher than the Scenario 1 case even though the temperature increase is only 9%, which should result in similar increases in plume rise.

3. Results

3.1 Worst-case calm wind scenario

Table 2: Summary of height vertical velocity is reduced to 4.3 m/s for single and multiple plumes for worst-case calm wind scenario

Gas turbine	Height at which average vertical plume velocity is less than 4.3 m/s (meters above ground level)	
	Scenario 1	Scenario 2
Single plume	198	208
Merged plumes	285	309

Table 3: Extent of plume at height critical plume velocity is achieved for calm wind scenario

Gas turbine	Horizontal extent of plume (meters)	
	Scenario 1	Scenario 2
Single plume	51	48
Merged plumes	76	83

Note: Scenario 1 horizontal extent revised from original report

Table 4: Average vertical velocity at various heights for calm wind scenario

		Average vertical velocity (m/s)	
		180 meters above ground level	240 meters above ground level
Scenario 1	Single Gas Turbine Plume	4.5	3.9
	Two Gas Turbine Plumes Merged	4.7	4.5
Scenario 2	Single Gas Turbine Plume	4.6	4.0
	Two Gas Turbine Plumes Merged	4.9	4.6

3.2 Realistic wind scenario

Table 5: Results for critical plume height for the proposed RCEC gas turbine scenarios and the proportion of the simulation year that the critical height is exceeded for a single and merged plume.

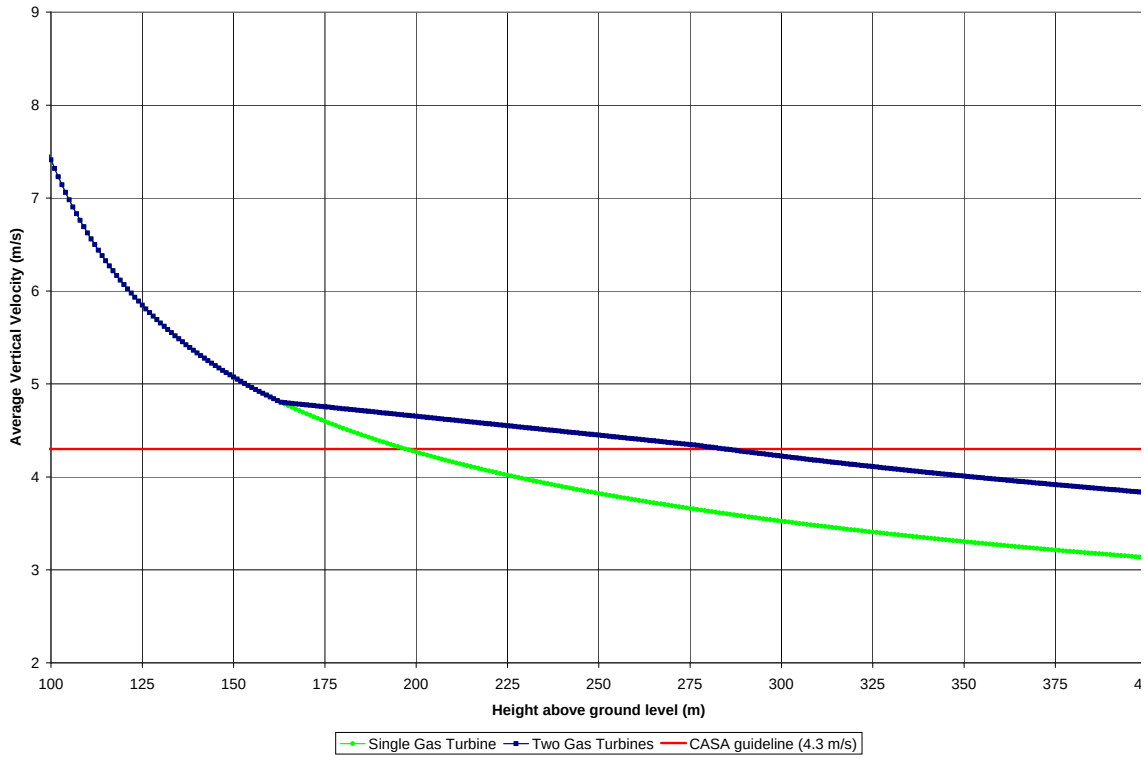
Percent of time (%)	Scenario 1		Scenario 2	
	Single GT TAPM results	Merged GTs KE Method	Single GT TAPM results	Merged GTs KE Method
90	59	64	59	65
80	59	68	59	68
70	60	72	64	73
60	65	76	65	77
50	66	80	66	82
40	67	86	71	87
30	72	92	73	94
20	78	101	78	104
10	100	116	101	119
9	100	118	101	121
8	101	120	102	123
7	102	122	103	126
6	103	125	104	129
5	104	128	105	134
4	105	132	107	140
3	107	136	109	147
2	111	142	129	154
1	132	150	133	162
0.5	134	156	136	171
0.3	136	159	155	177
0.2	152	161	157	182
0.1	157	167	160	187
0.05	160	175	164	195

Table 6: Predicted plume extent (plume radius + distance downwind in meters) where the average vertical velocity exceeds the 4.3 m/s threshold for various heights, using Katestone methodology for the RCEC for the TAPM simulation year 1994.

Plume extent	Height					
	75	**100**	**125**	**150**	**175**	**200**
Scenario 1						
Maximum	25	28	28	35	31	NA
Average	14	18	22	26	31	NA
Minimum	5	7	14	21	31	NA
Scenario 2						
Maximum	25	29	32	40	40	42
Average	14	19	23	29	34	42
Minimum	5	7	13	21	31	42

Figure 1: Predicted average vertical plume velocity with height for worst-case calm wind conditions and neutral stability for all heights for (a) Scenario 1 gas turbines and (b) Scenario 2 gas turbines.

(a) Scenario 1



(b) Scenario 2

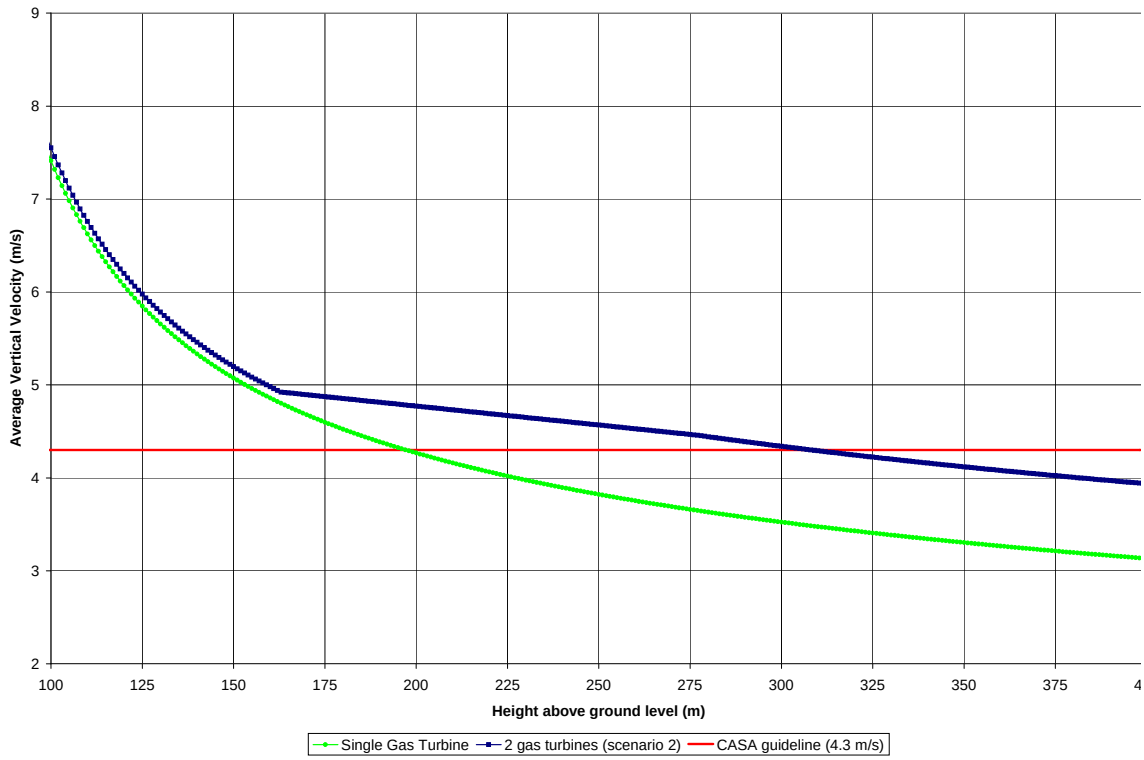


Figure 2: Frequency distribution of critical plume height (meters) for both gas turbine merged plume scenarios using the Katestone Method and TAPM meteorology for one year

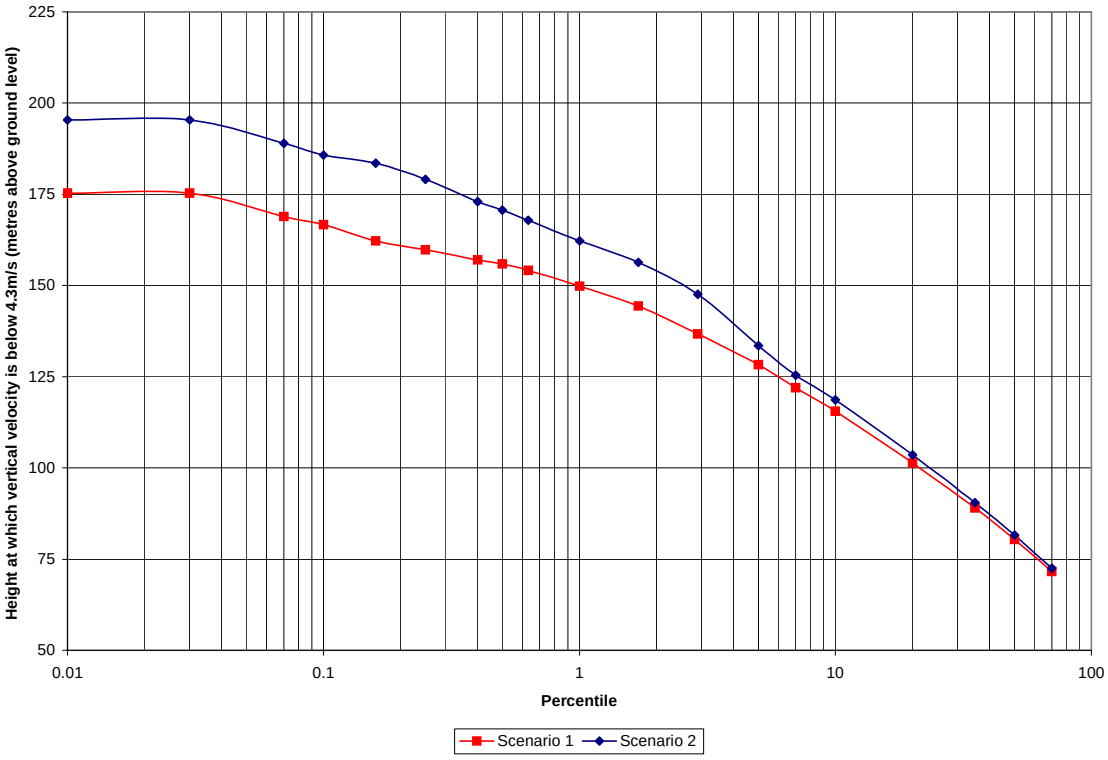
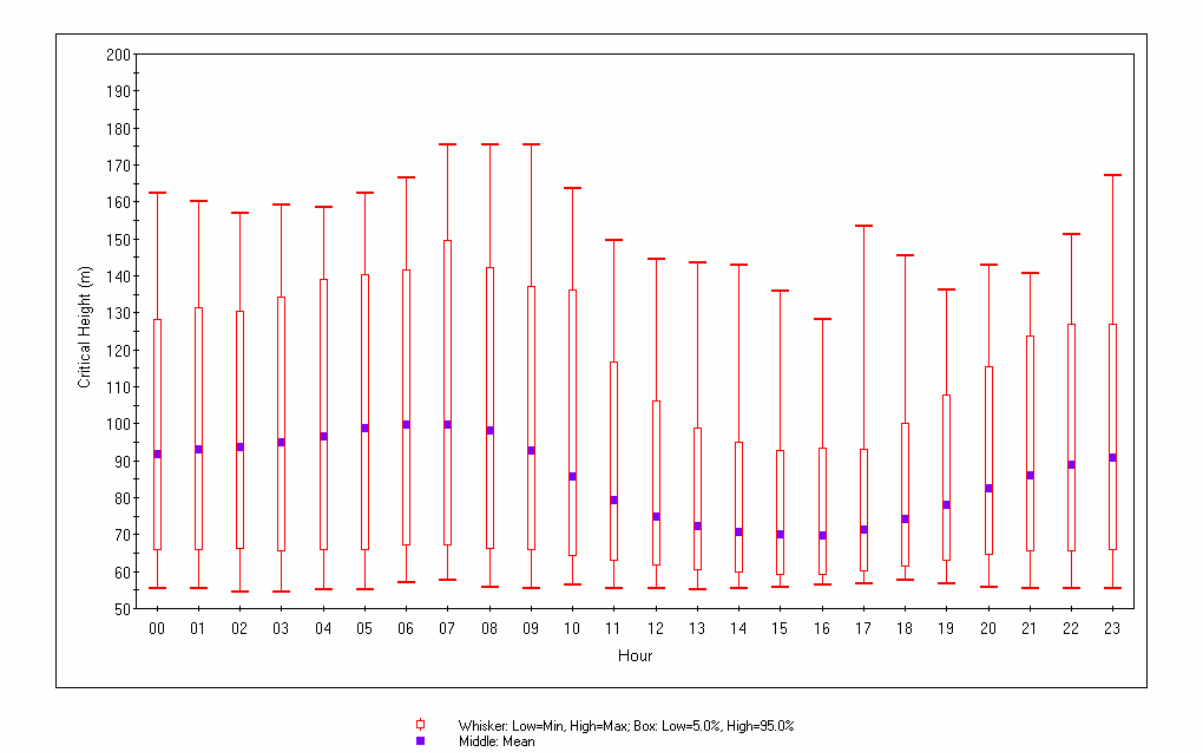


Figure 3: Box and whisker plot of the critical plume height (meters) versus hour of day for the merged plume results for the two gas turbine units

a) Scenario 1: Katestone Environmental Method



b) Scenario 2: Katestone Environmental Method